

A scanning electron micrograph (SEM) showing the intricate structure of male moth sex scales. The scales are arranged in overlapping, wavy rows, creating a textured, almost woven appearance. The background is dark, highlighting the detailed structure of the scales.

# Male Sex Scales of Moths

Richard L. Brown, Joaquin Baixeras, Sangmi Lee

# Historical Work

- Baillif (1825) - first record of microscopic male-limited structures (in *Pieris rapae*).

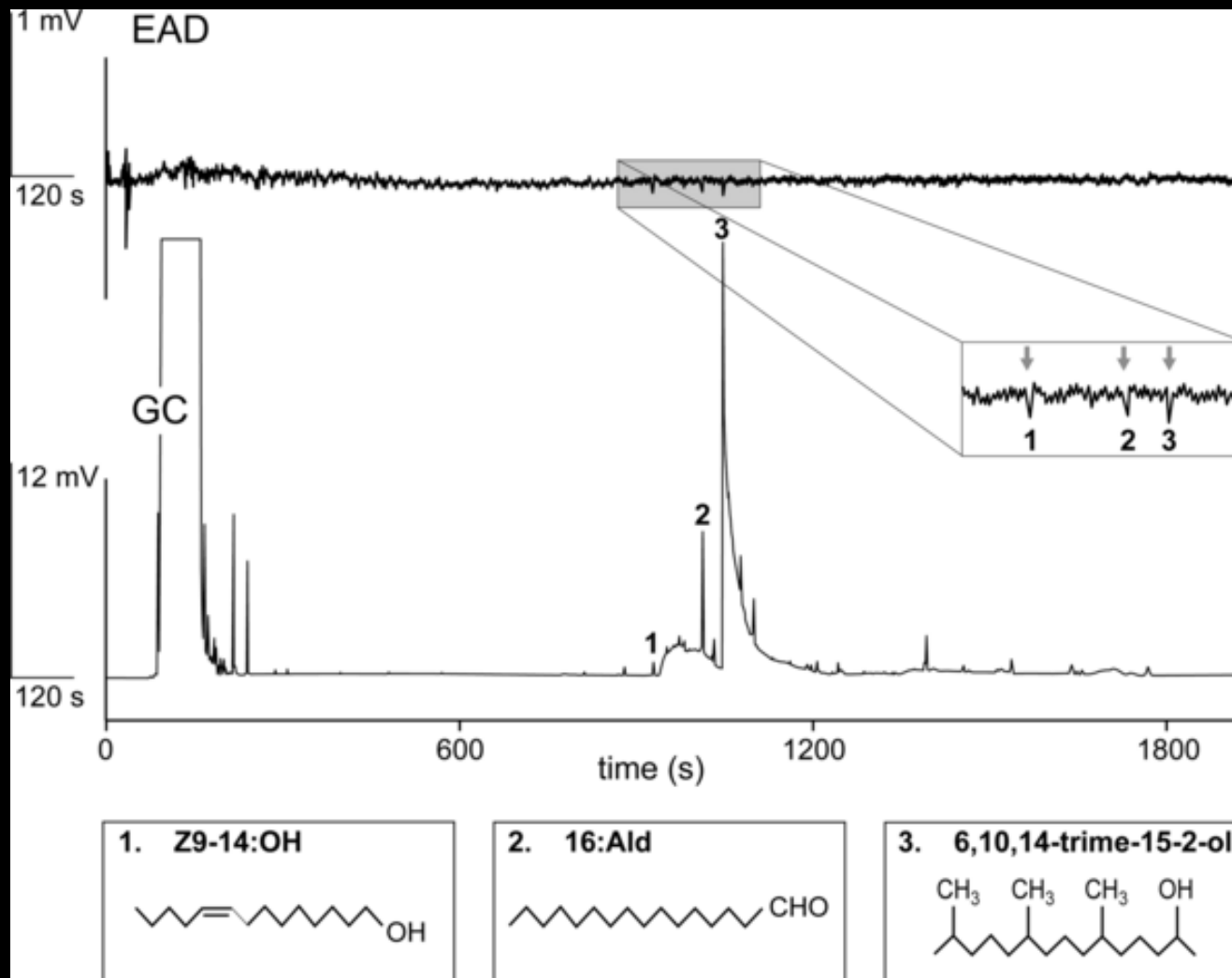
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- Scudder (1877) - used term “androconia” for “antigeny” (sex-limited) structures.
- Fritz Muller (1877 and subsequent works) - “Odoriferous organs.” “...diffuse scents, which are undoubtedly agreeable to the females and arouse their sexual desires.”

# Male Pheromone of *Bicyclus anynana*



(Z)-9-tetradecenol

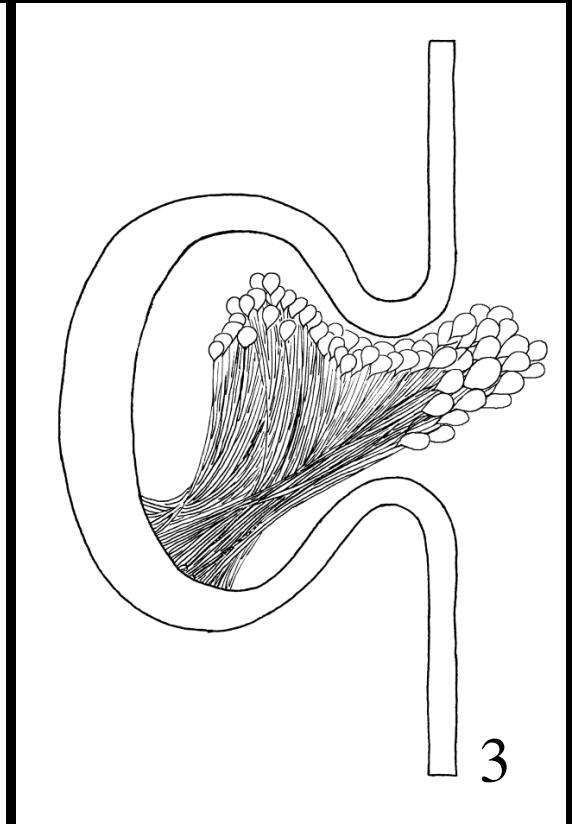
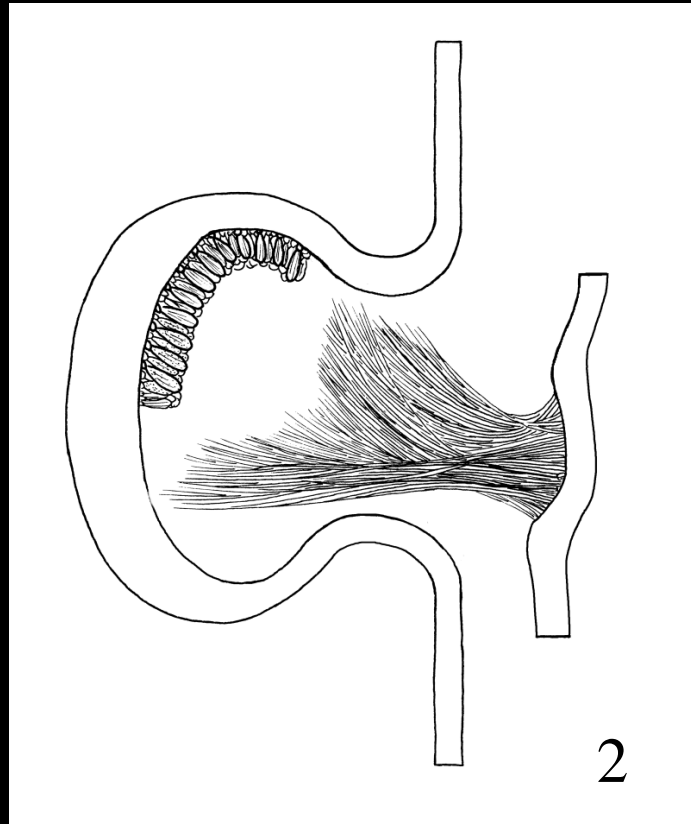
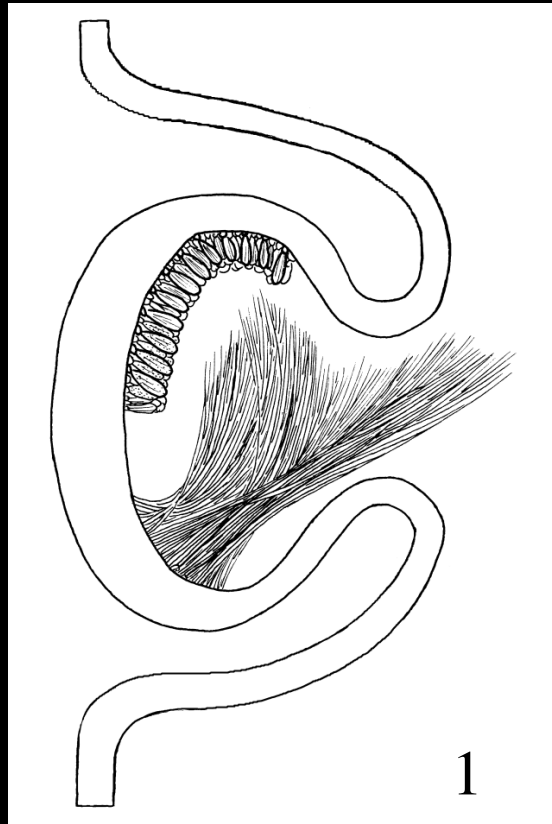
hexadecanal

trimethylpentadecan

(Nieberding, C.M et al. 2008. PLoS ONE 3(7): e2751)

# Three Components of Scent Producing Systems

1. Glands for scent production  
(may be associated with scale or other structure).
2. Structures for scent dissemination
3. Protective pockets



1. Protective pocket enclosing glandular scales and disseminator scales.
2. Protective pocket with glandular scales; disseminator scales separate.
3. Protective pocket with scales having both scent producing and disseminating functions.

# Terminology

1. Coremata - eversible tube-like organs in abdomen with associated glands for scent production.



D. Shelton in Davenport & Connor (2003)



Tumbir\_darren

# Terminology

Androconia - Scales with glandular cells at their bases for scent production  
(Hallberg and Poppy in Kristensen, 2003).



*Bicyclus*

G. San Martin



*Pieris bassicae*

Power & Syred

# Terminology

Hairpencils - hair-like scales involved in dissemination (some are scent producing).



# Terminology

1. Descriptive vs. functional terminology -scent producing scales, disseminating scales, and protective pockets.

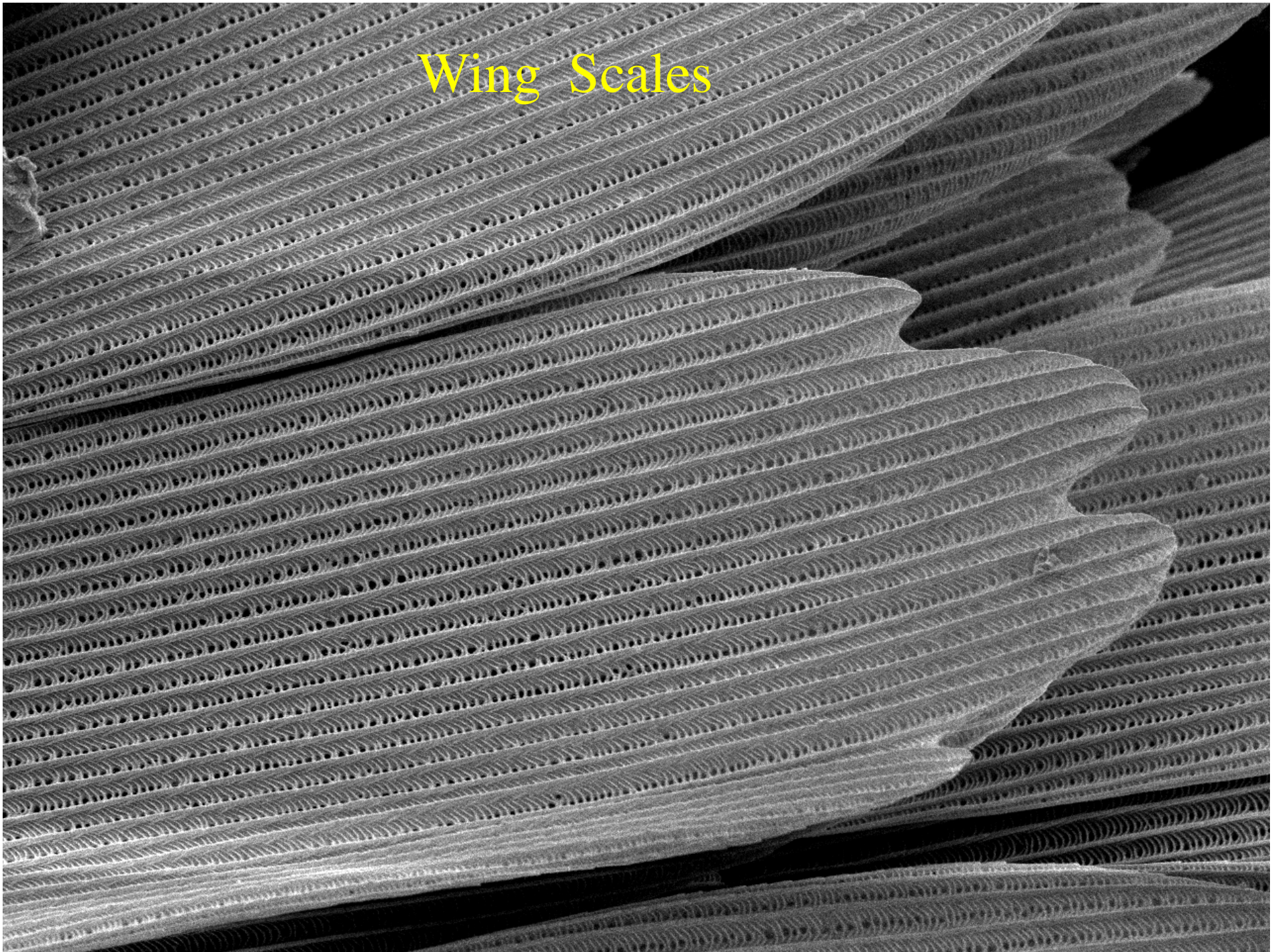
# Terminology

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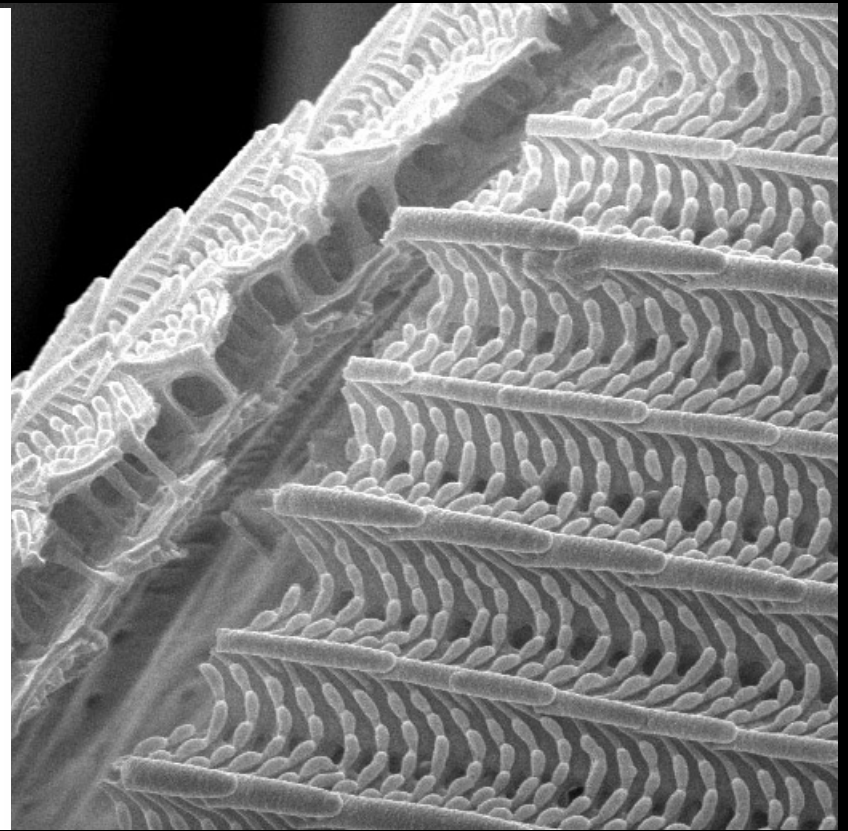
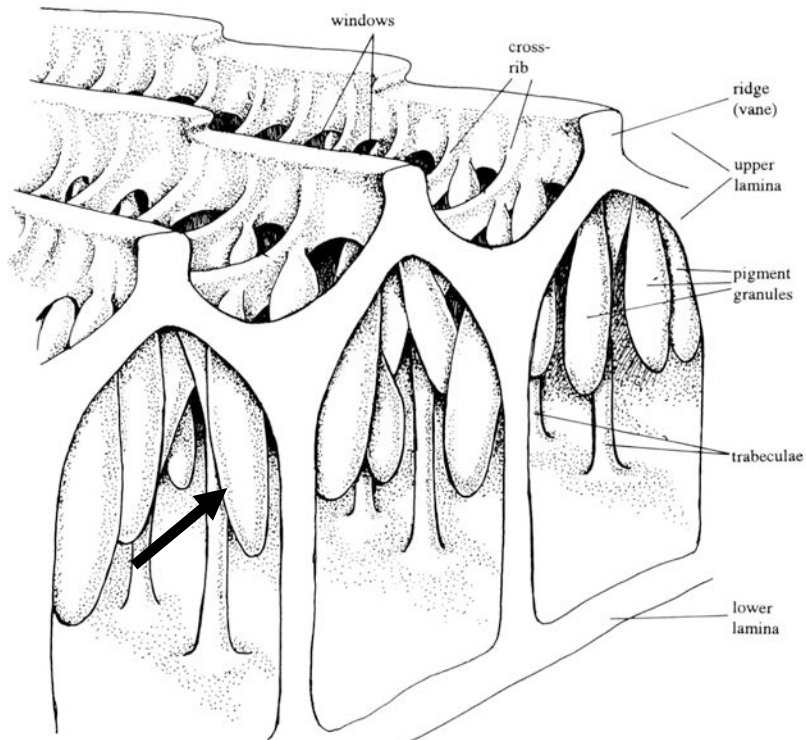
# Terminology

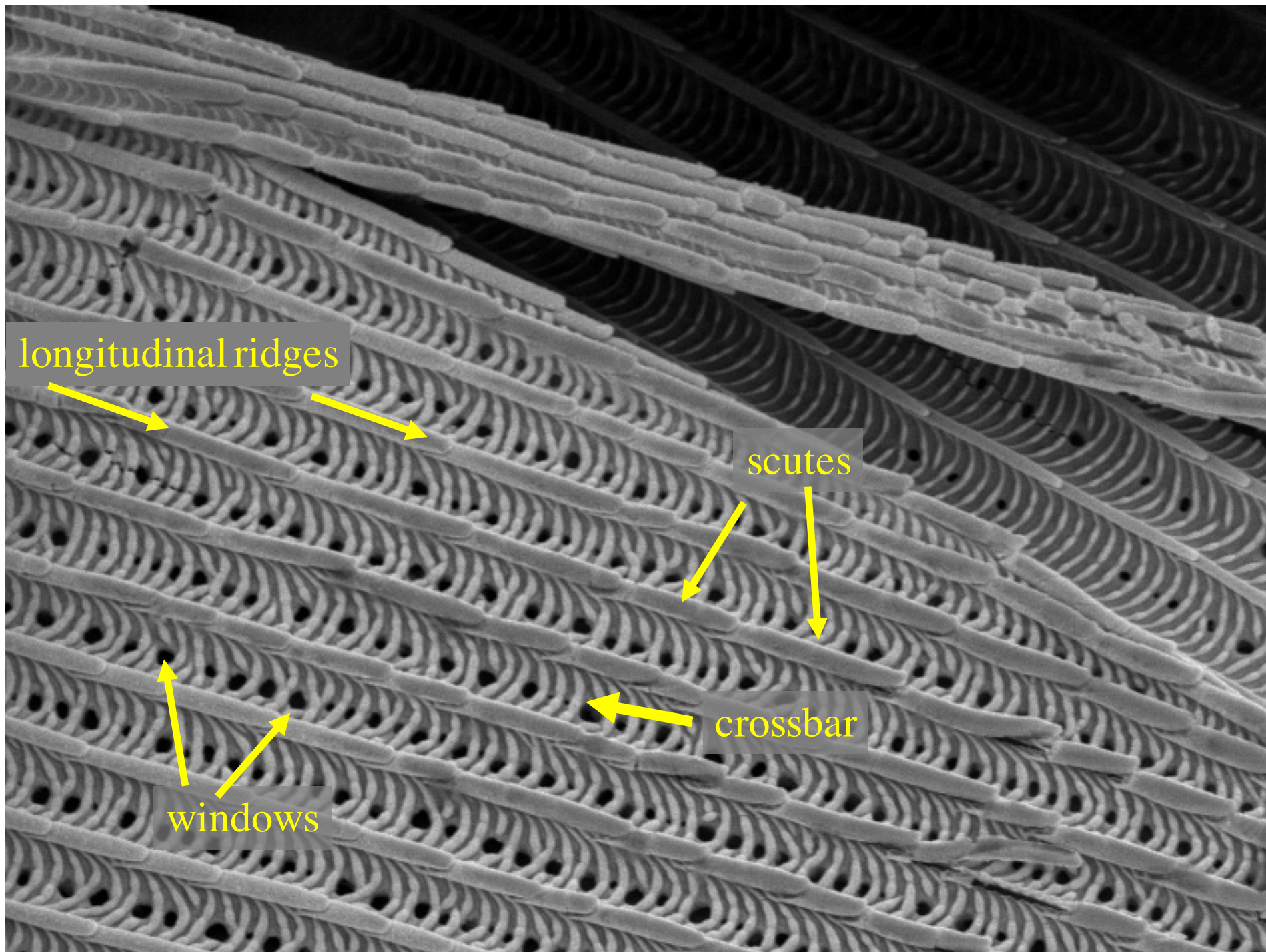
1. Descriptive vs. functional terminology -scent producing scales, disseminating scales, and protective pockets.
2. Specialized scales and structures may be present but with loss of function , e.g., presence of costal fold without an enclosed hair pencil.
3. “Sex scale” - a generalized term for specialized scales present only in males, without implying functionality.

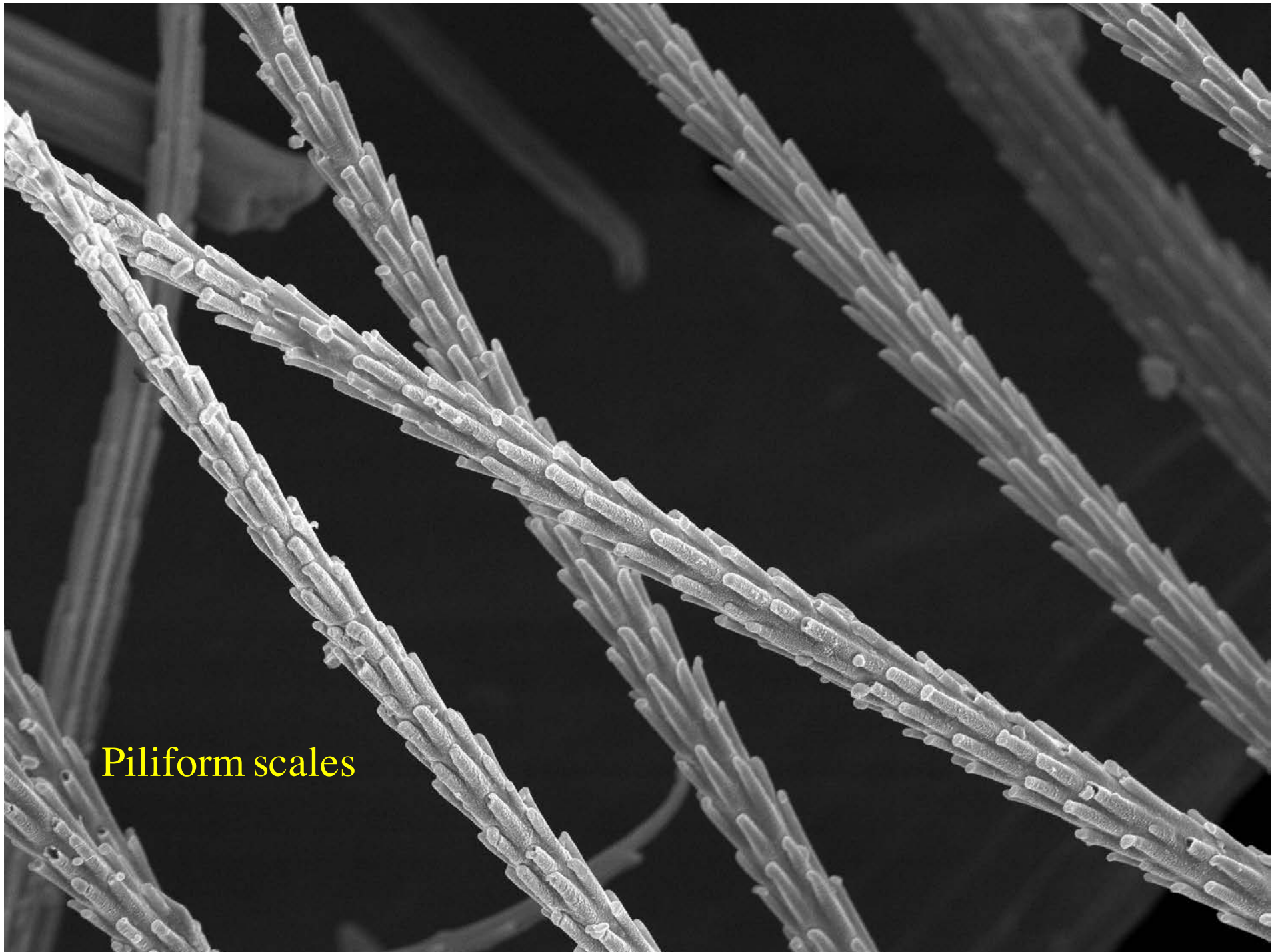
# Wing Scales



# Hollow Scales







Piliform scales

# Diversity of Sex Scales in Lepidoptera



# Taxa with High Diversity of Sex Scales

Gelechiidae

Tortricidae

Pyralidae

Papilionoidea

Notodontidae

Erebidae

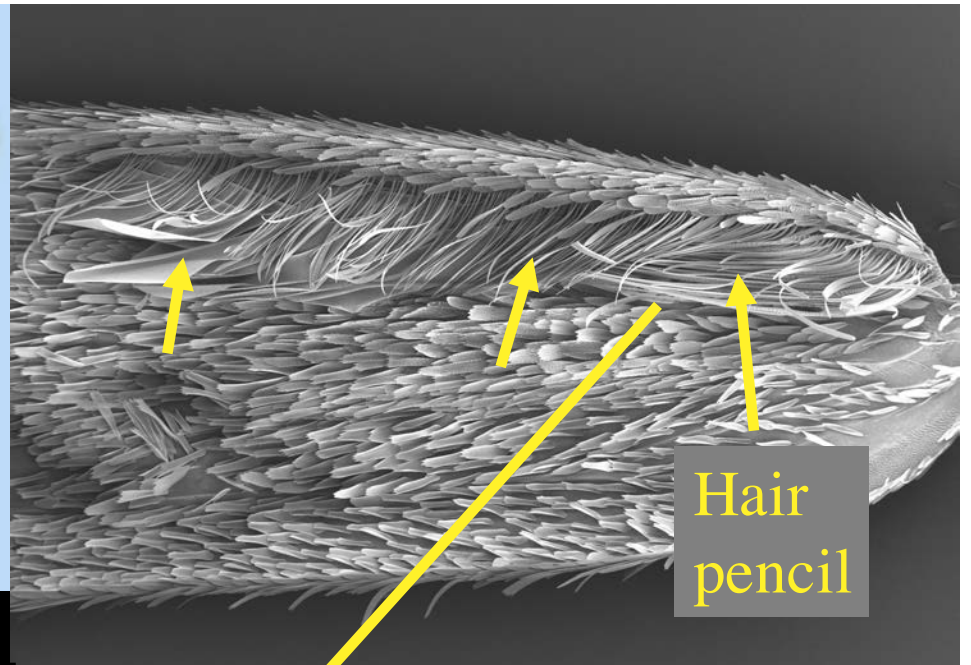
Noctuidae

# Gelechiidae

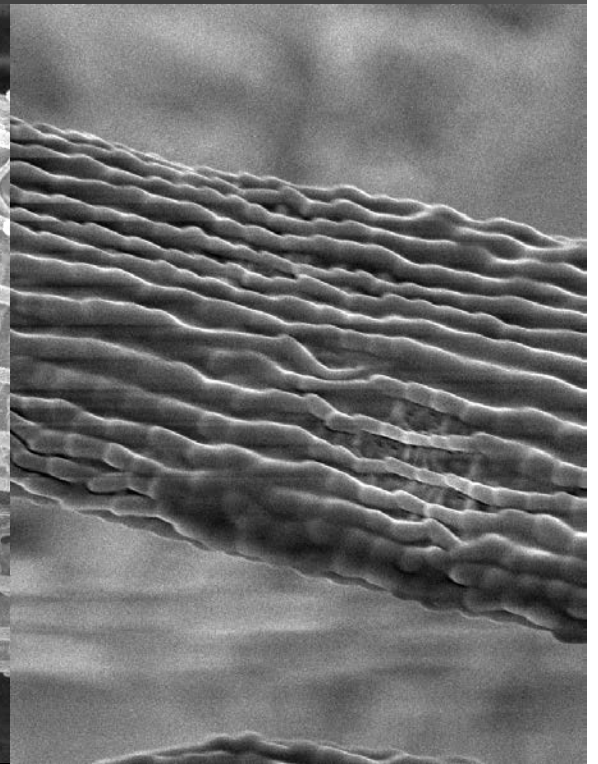
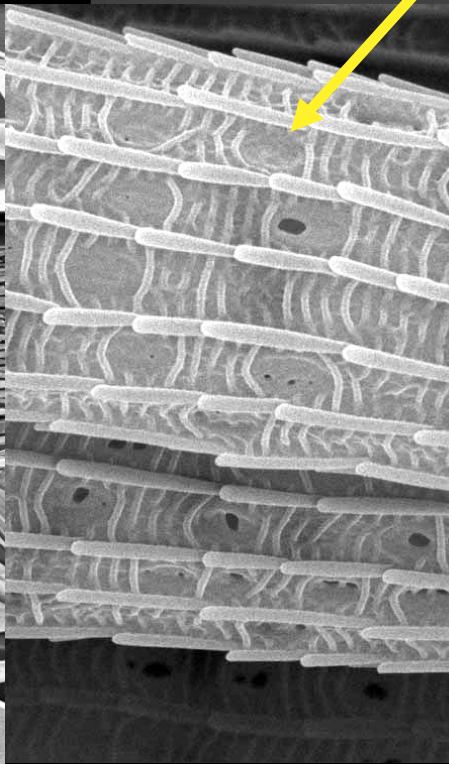
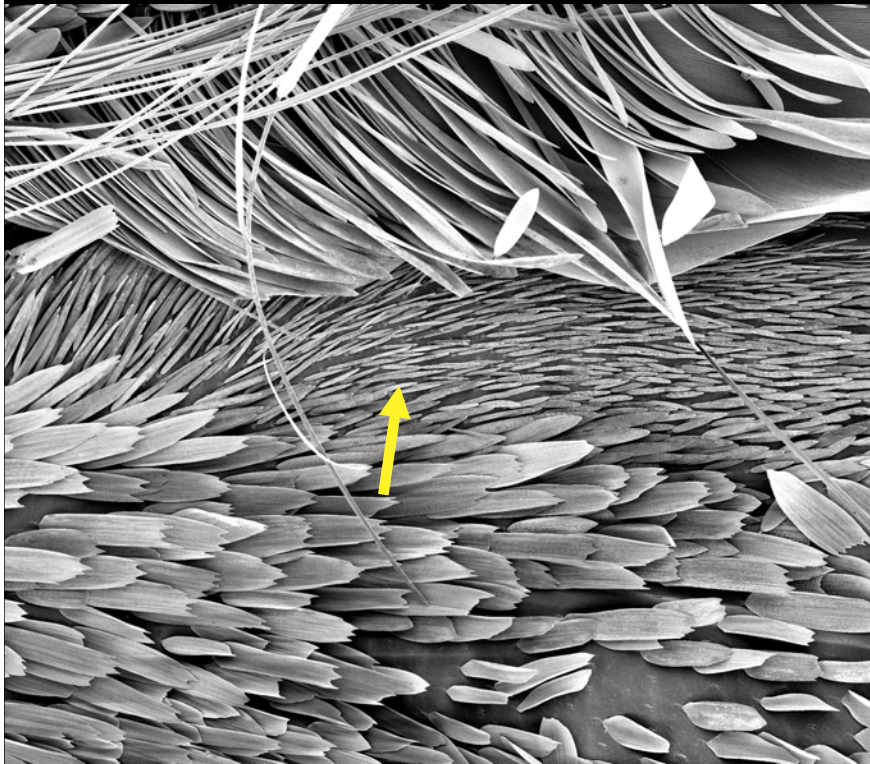




*Stegasta bosqueella*

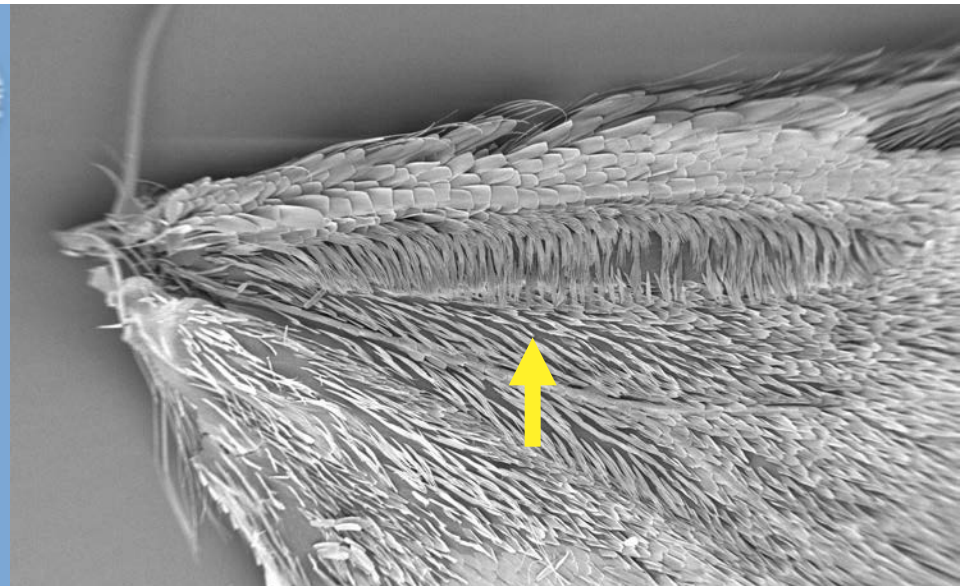


Hair  
pencil

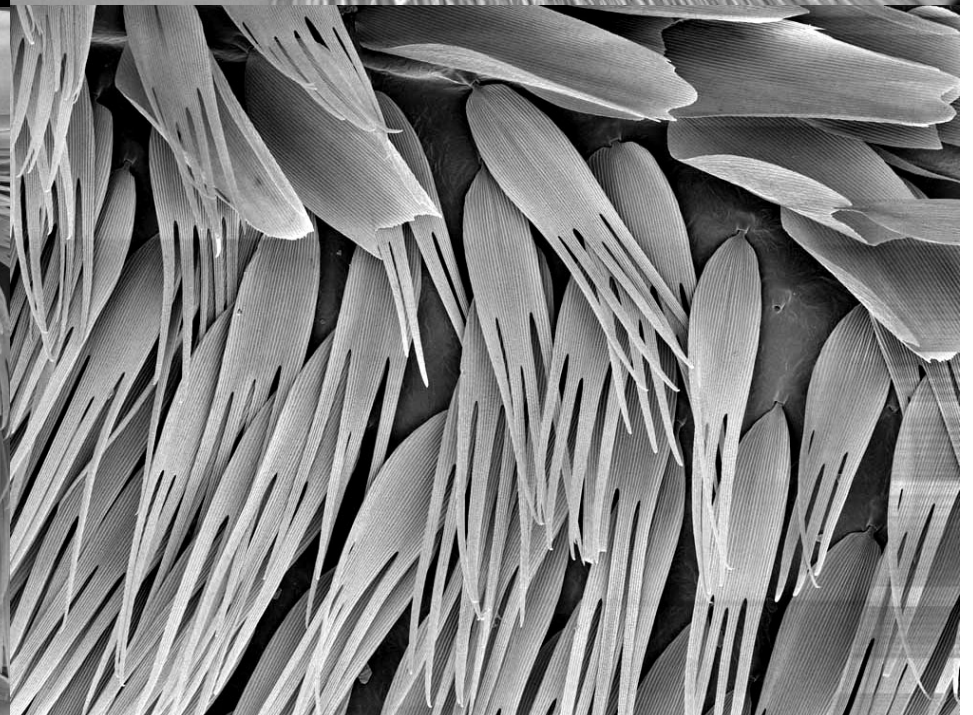
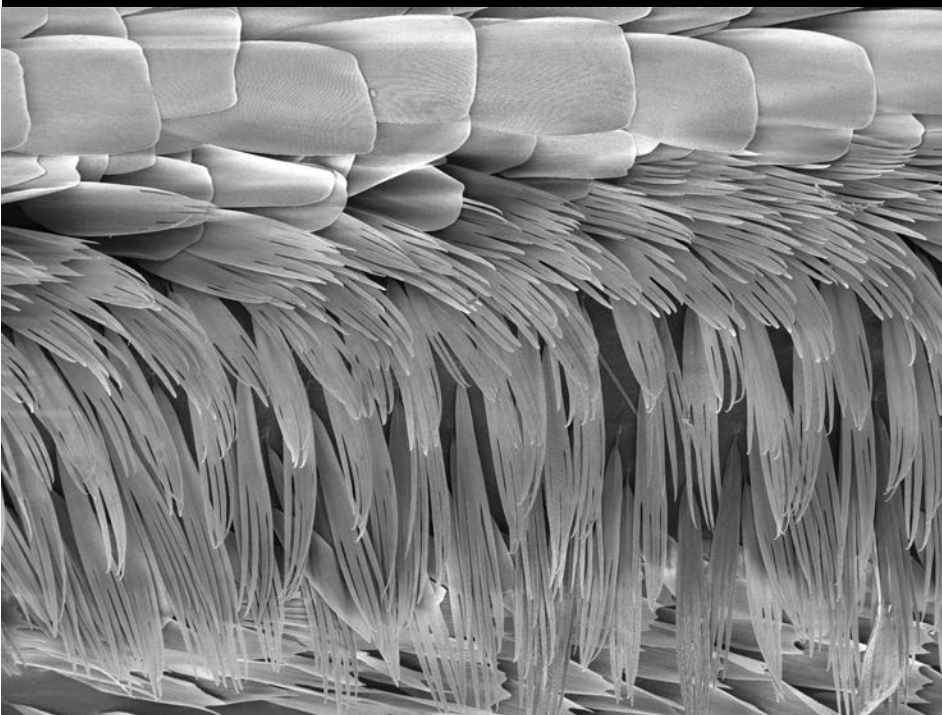




*Filatima serotinella*

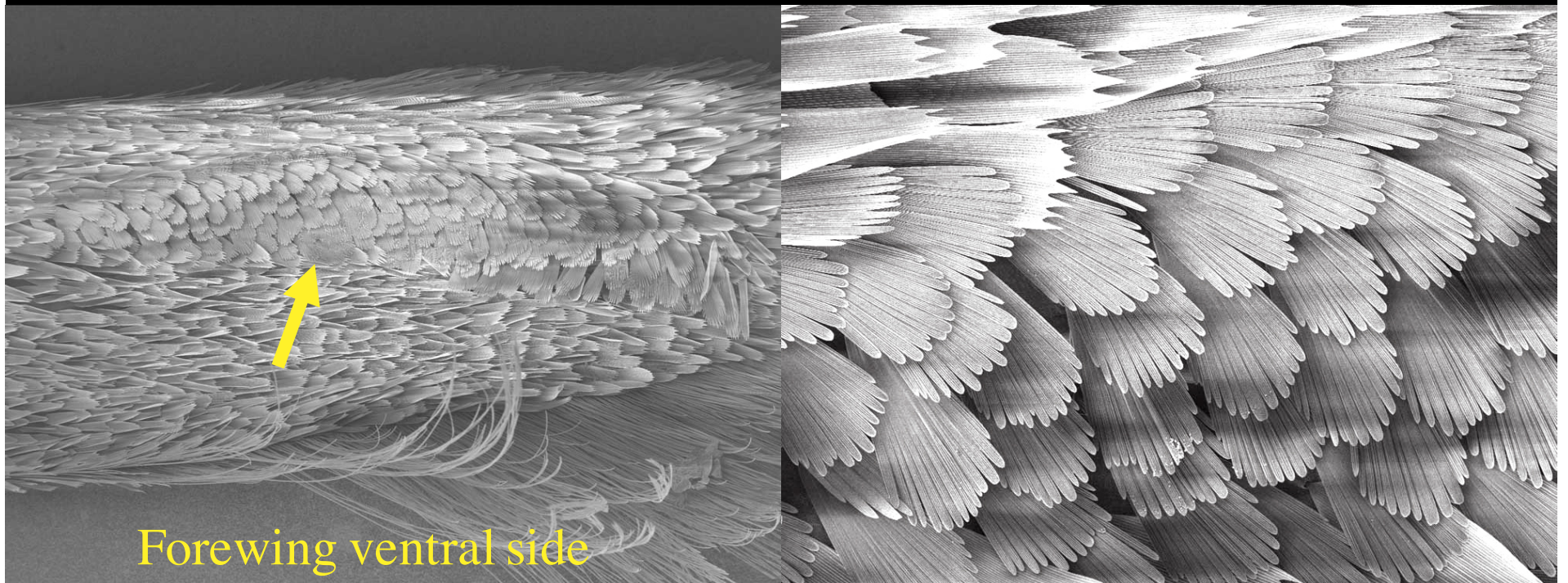


Hindwing curtain scales





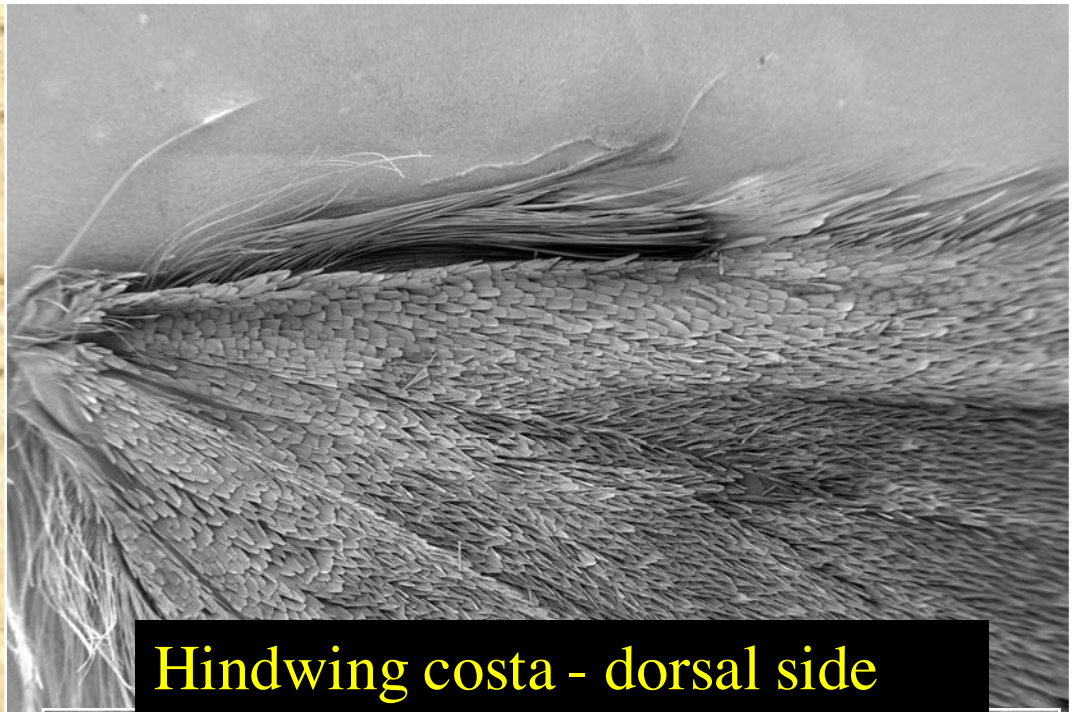
*Exotelia pinifoliella*



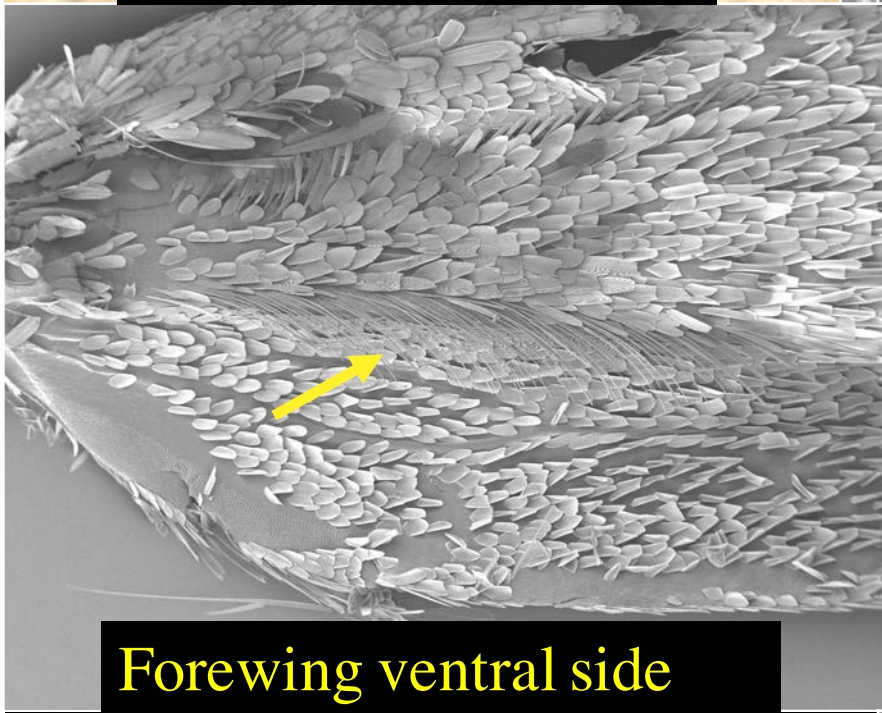
Forewing ventral side



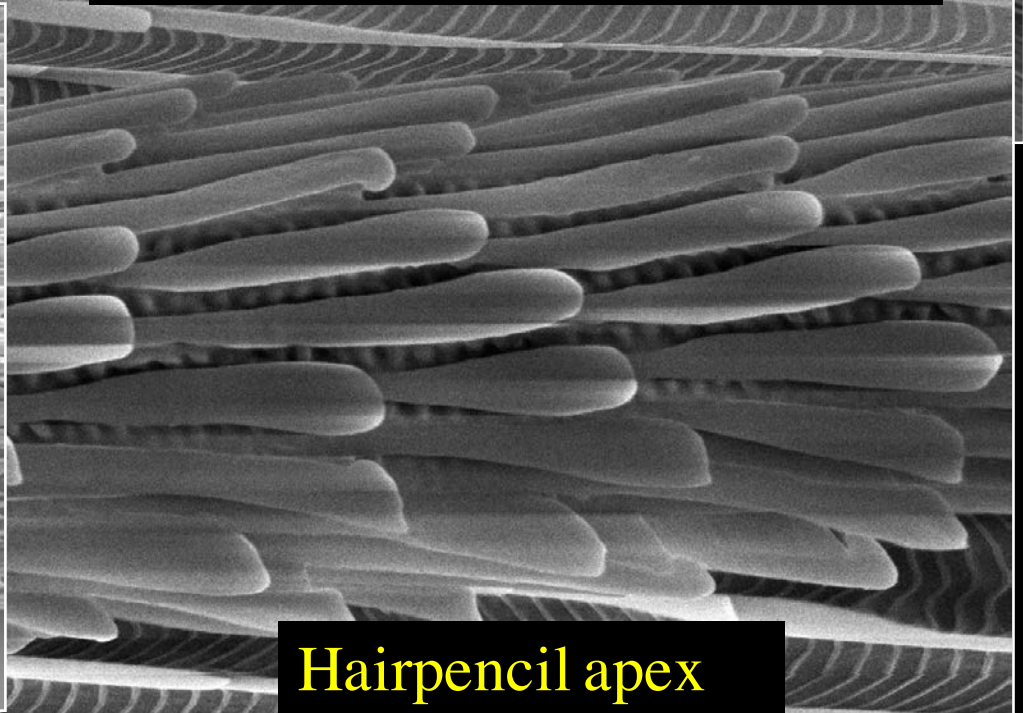
*Aroga compositella*



Hindwing costa - dorsal side



Forewing ventral side

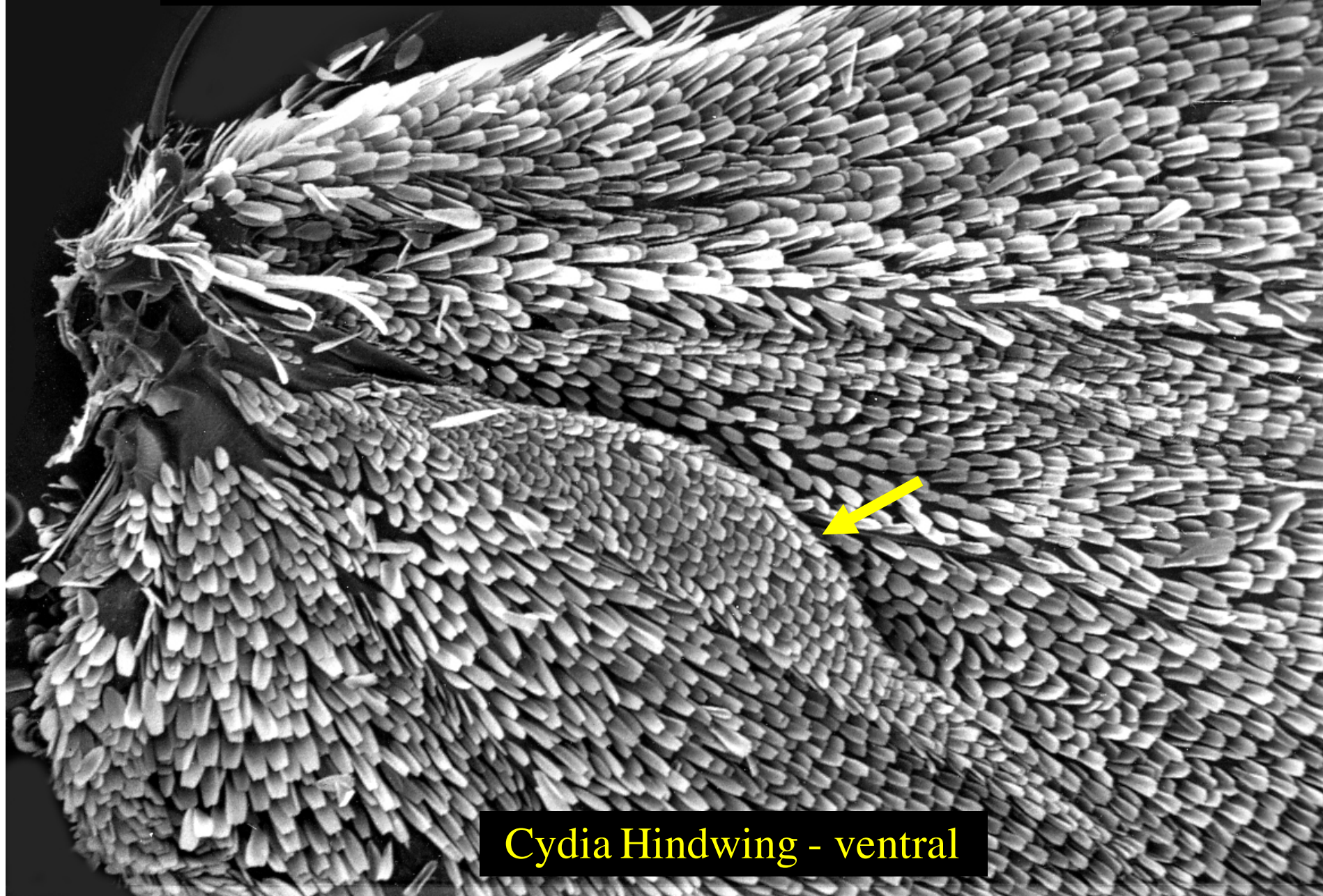


Hairpencil apex

# Tortricidae



Glandular and Disseminator Scales in Same Pocket - I

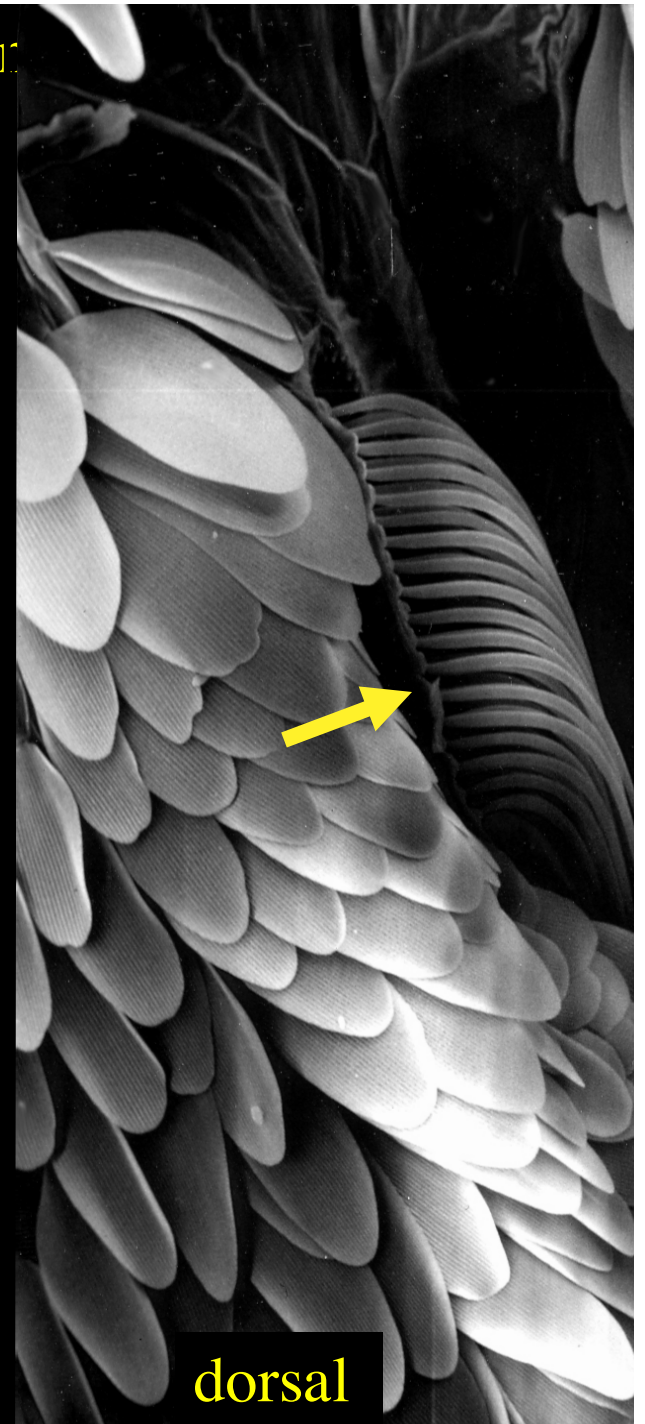


Cydia Hindwing - ventral

# Cydia Hindwings

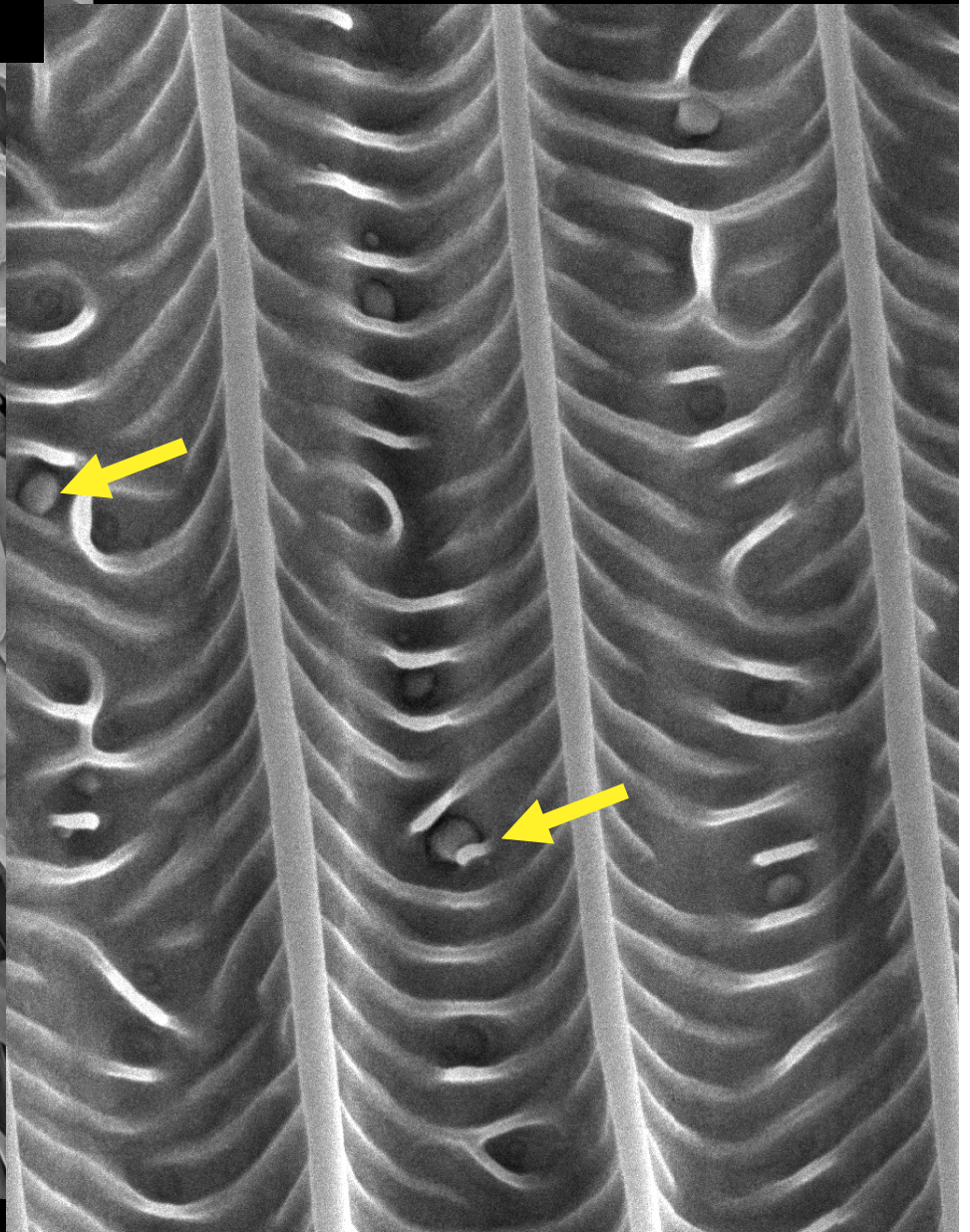
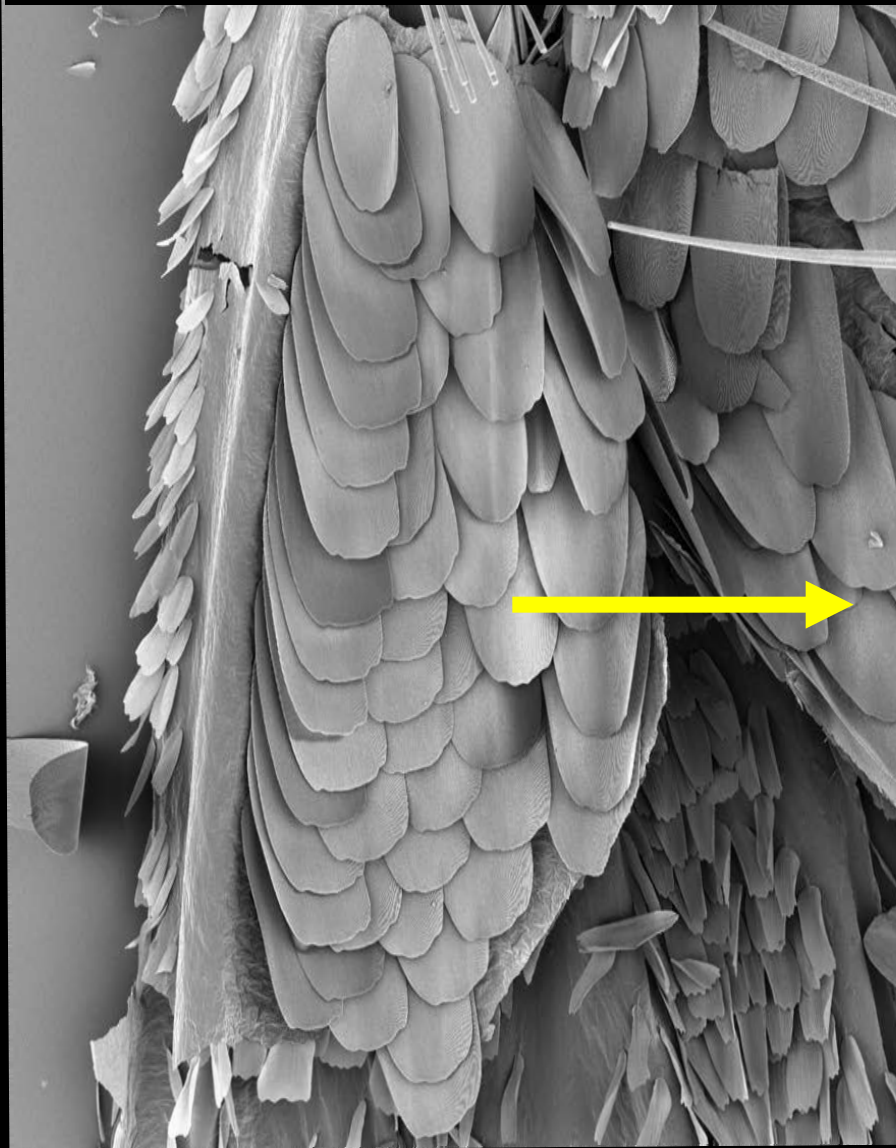


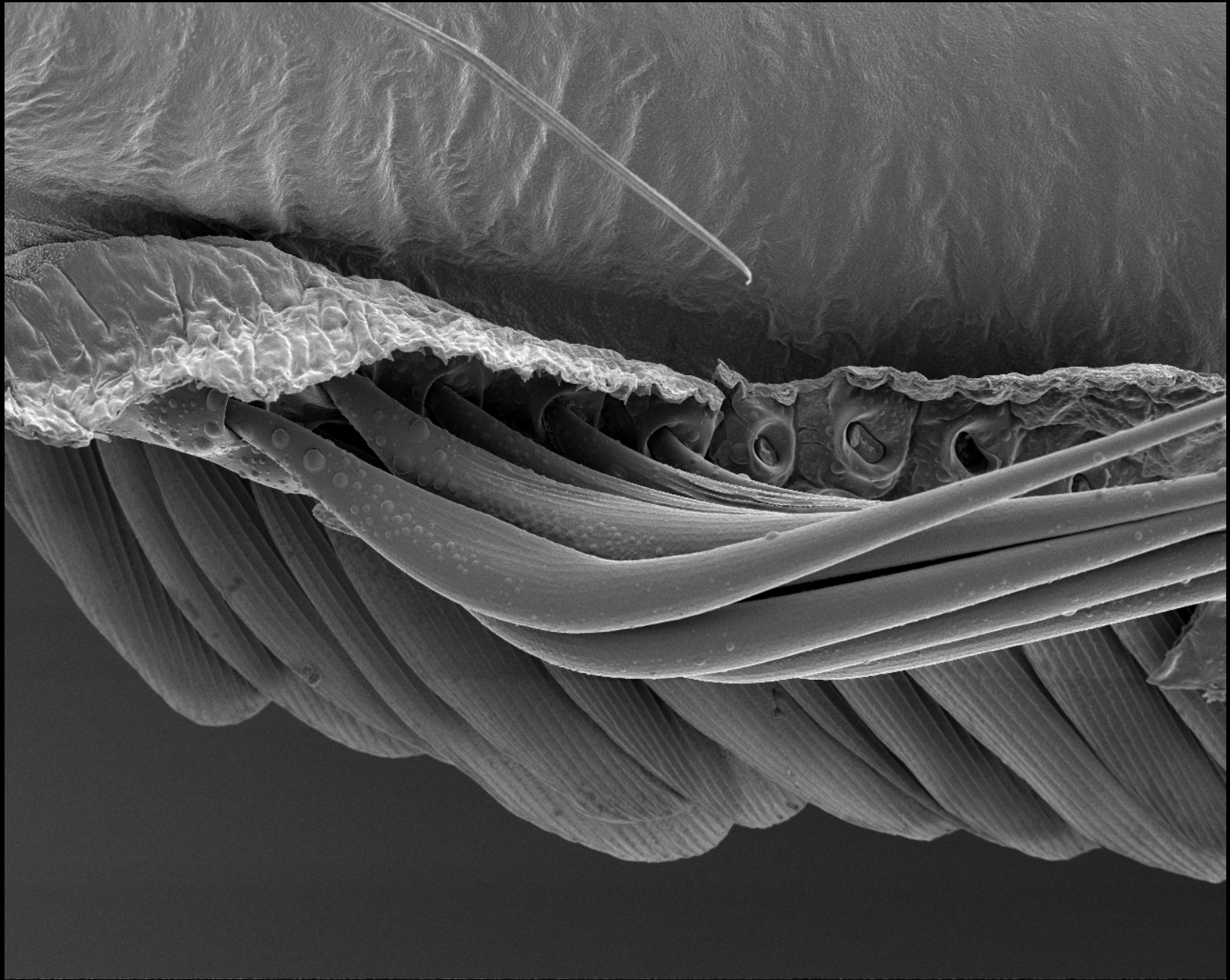
ventral

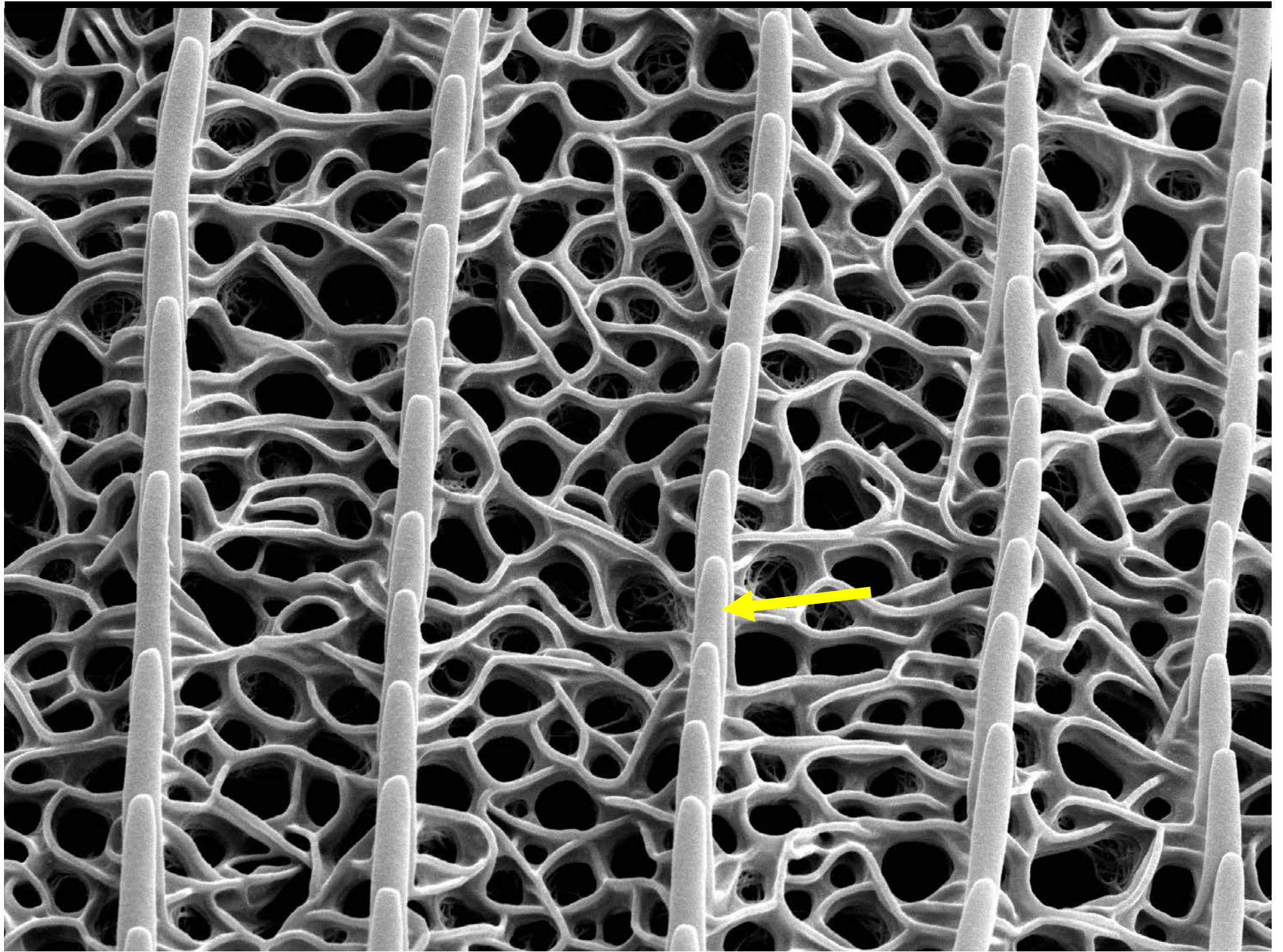


dorsal

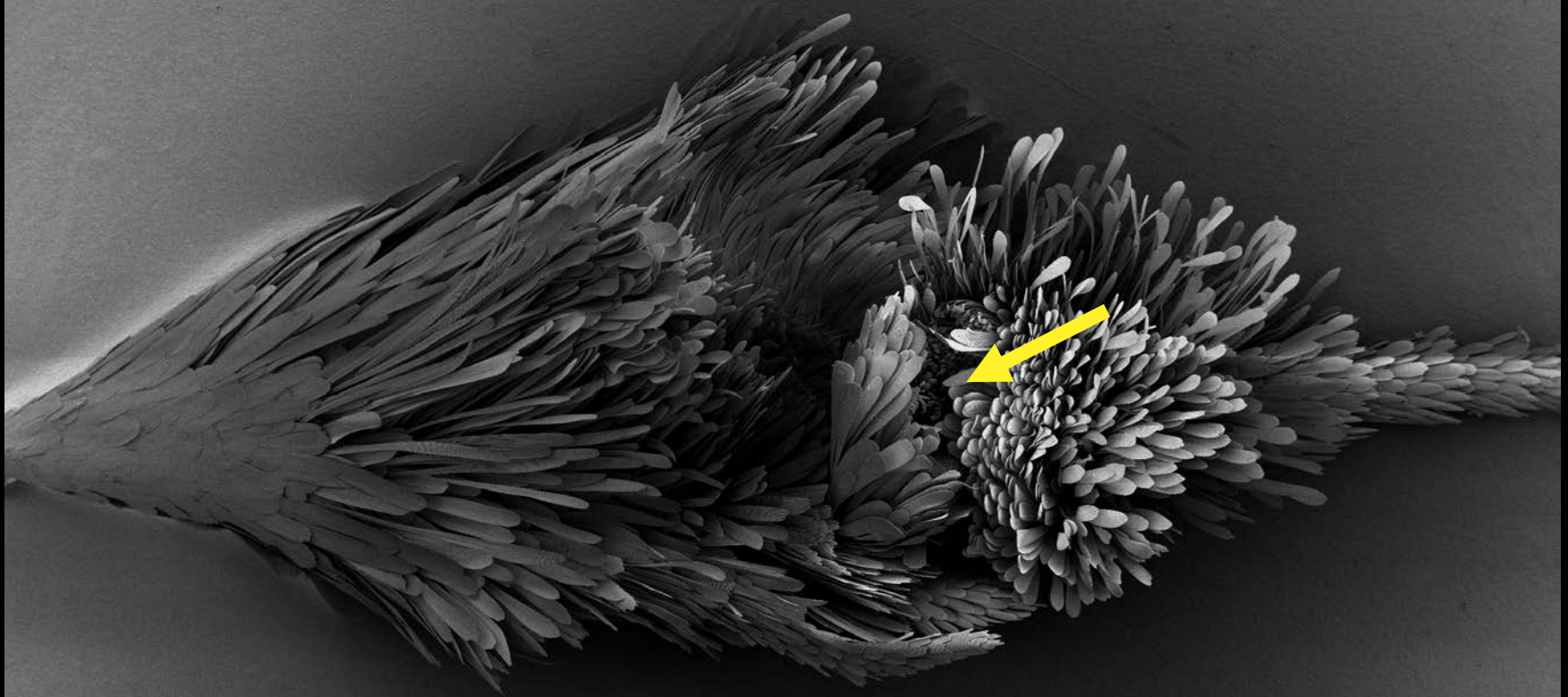
## Cydia Hindwing Pocket Opened



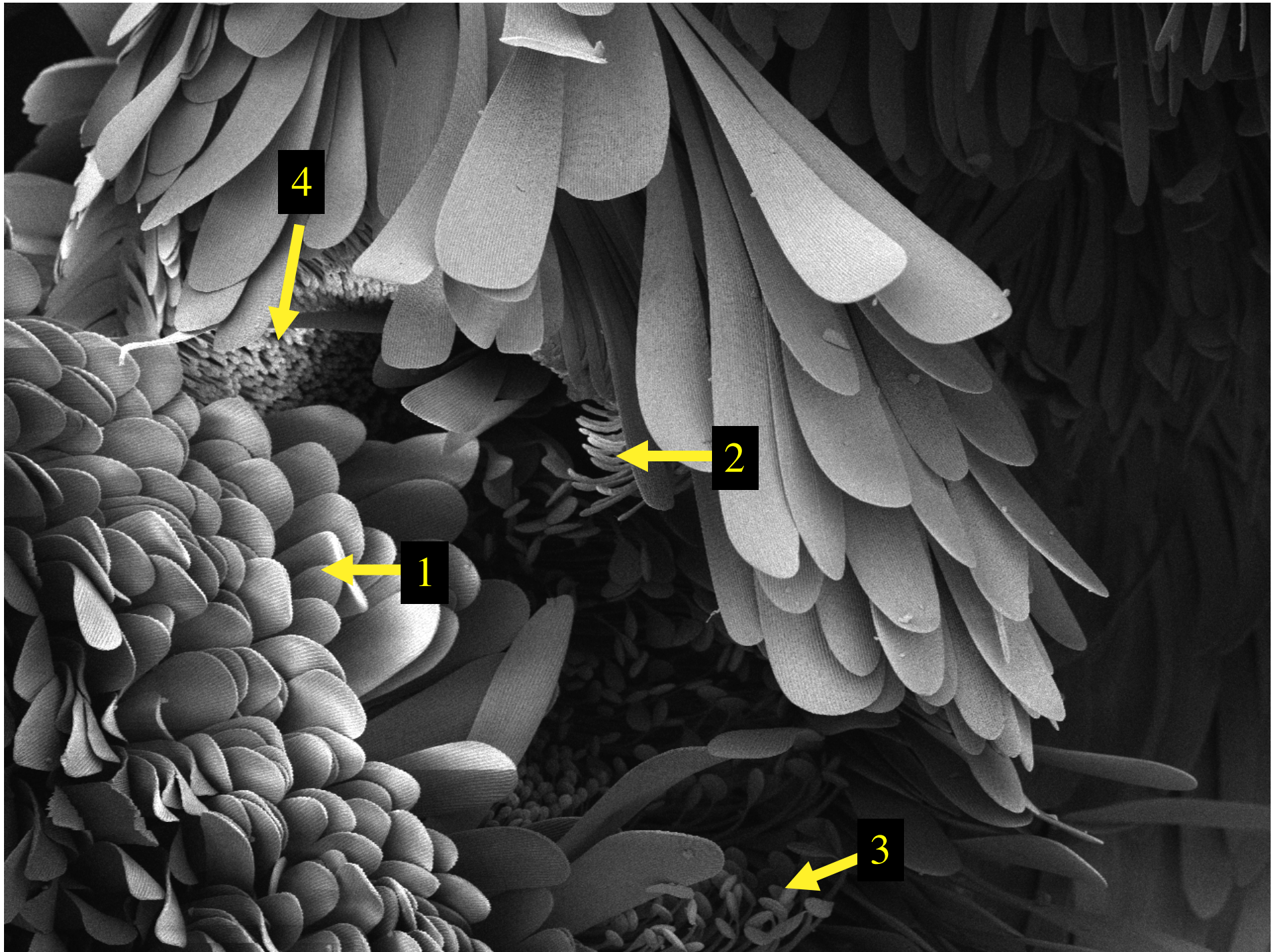


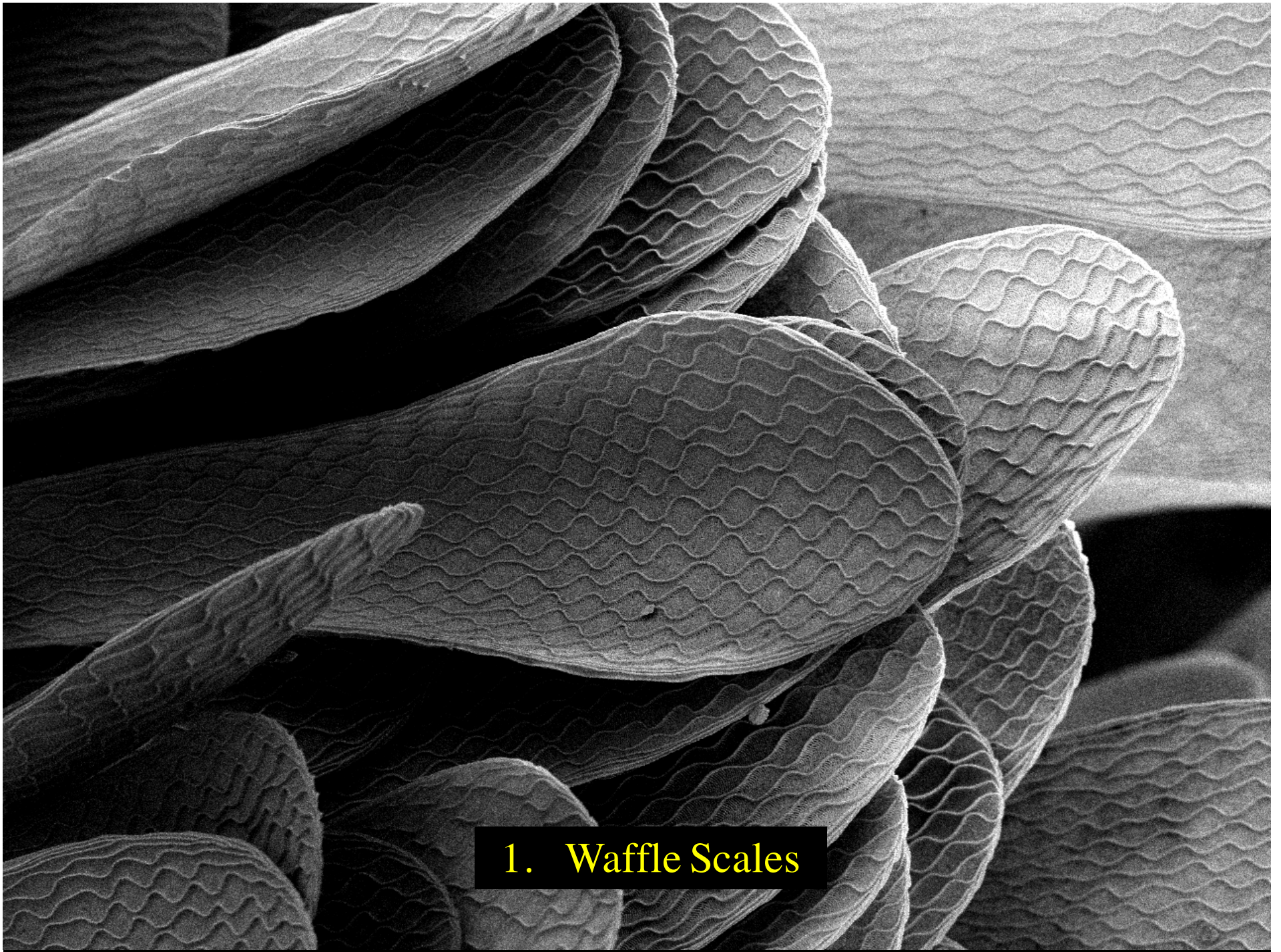


## Glandular and Disseminator Scales in Same Pocket - II

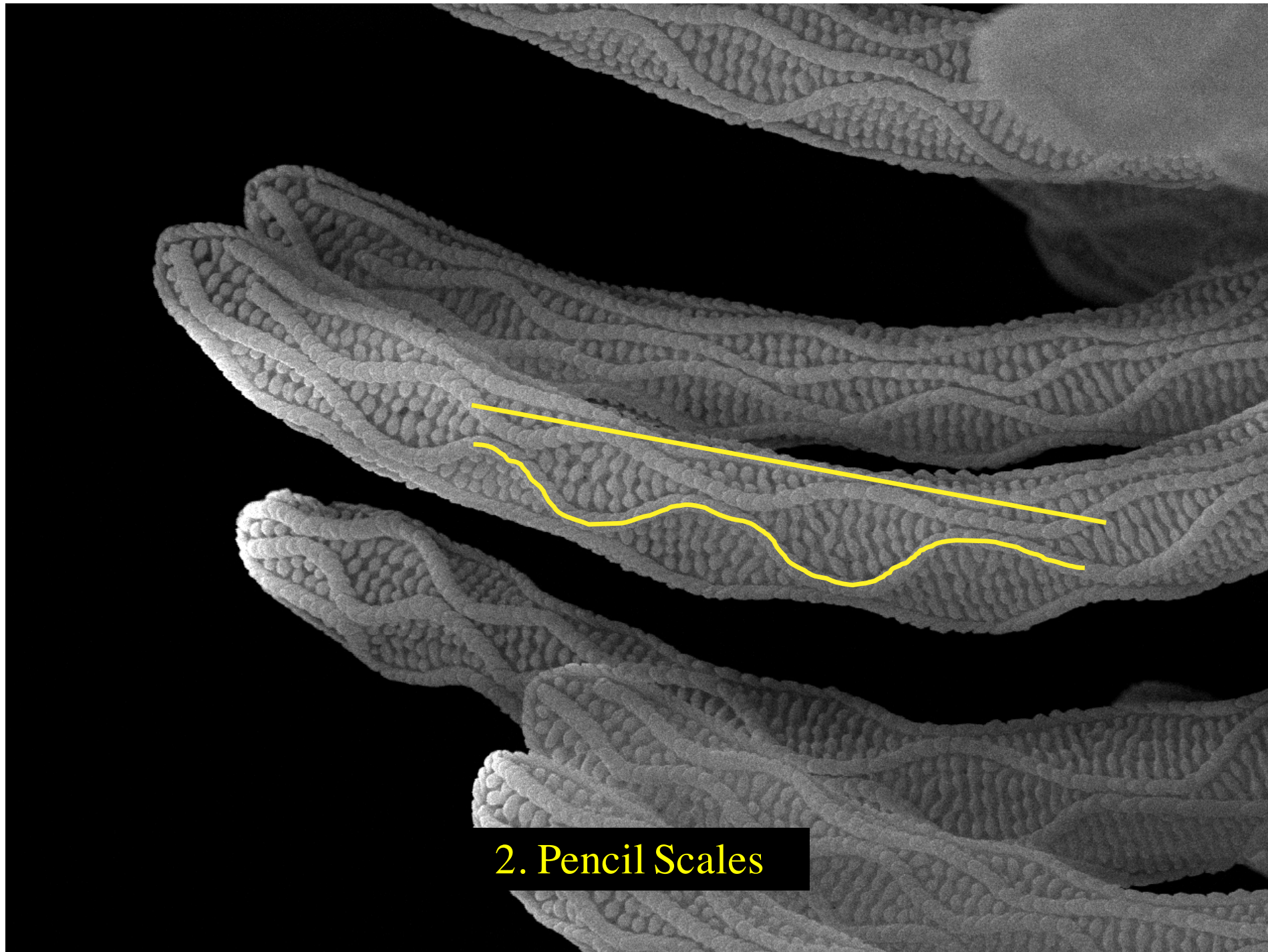


Hindleg of *Thaumatotibia leucotreta*

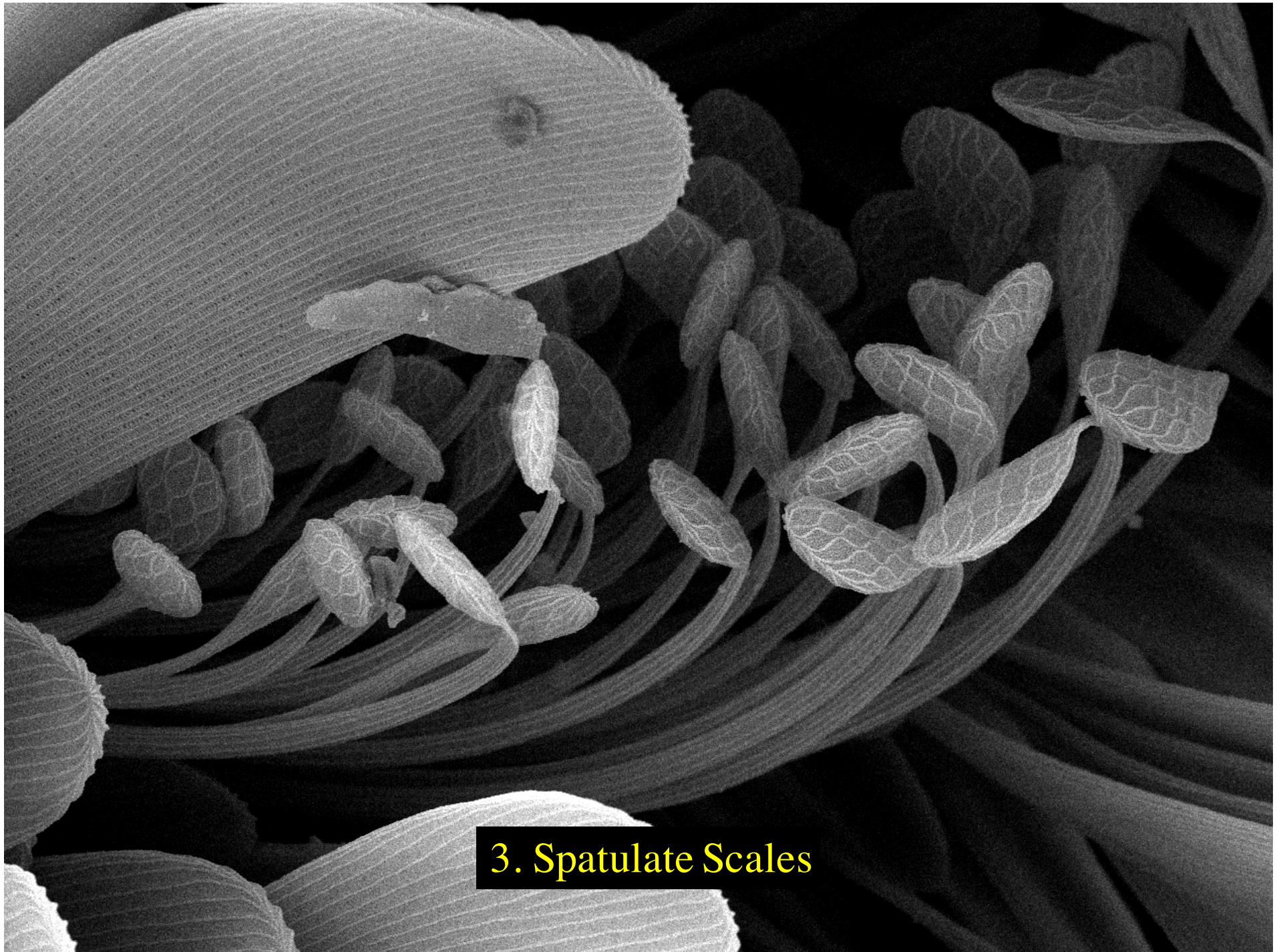




## 1. Waffle Scales

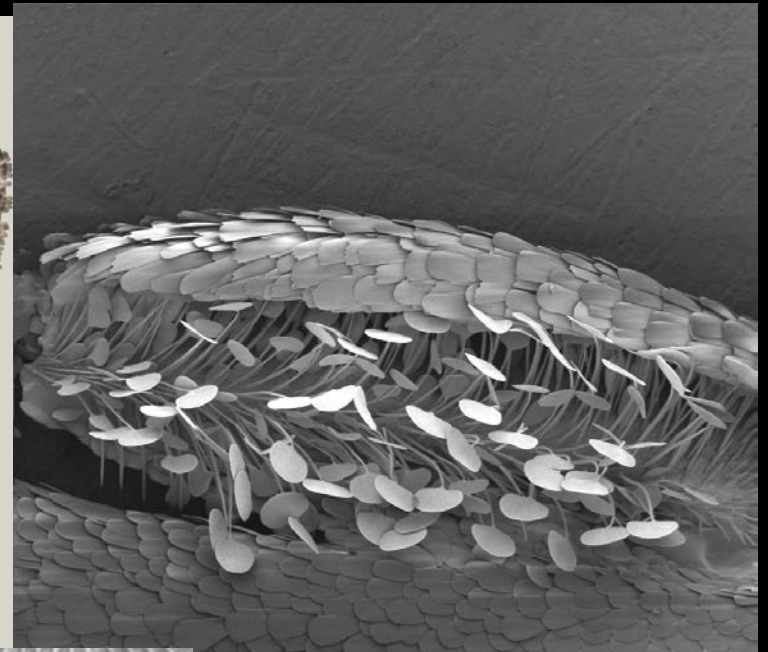
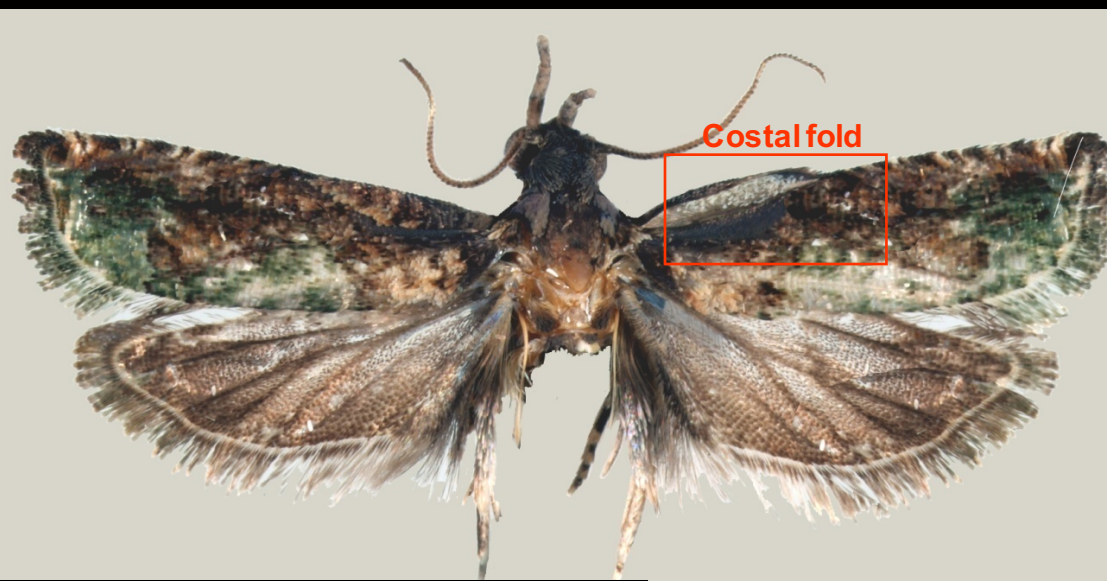


2. Pencil Scales

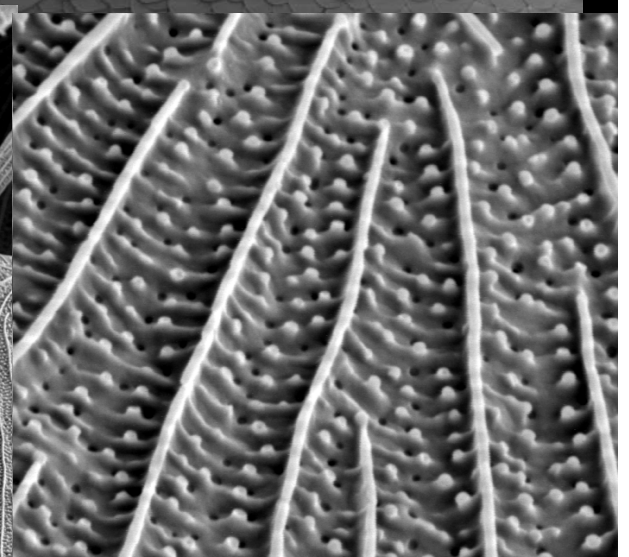
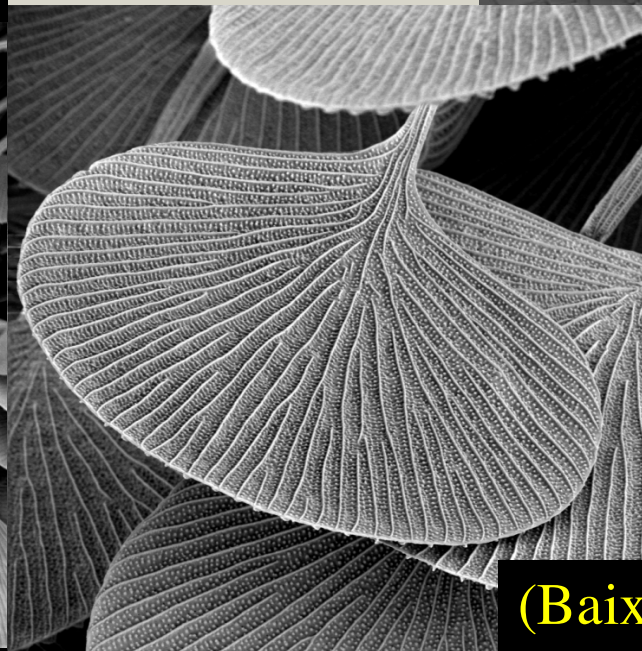
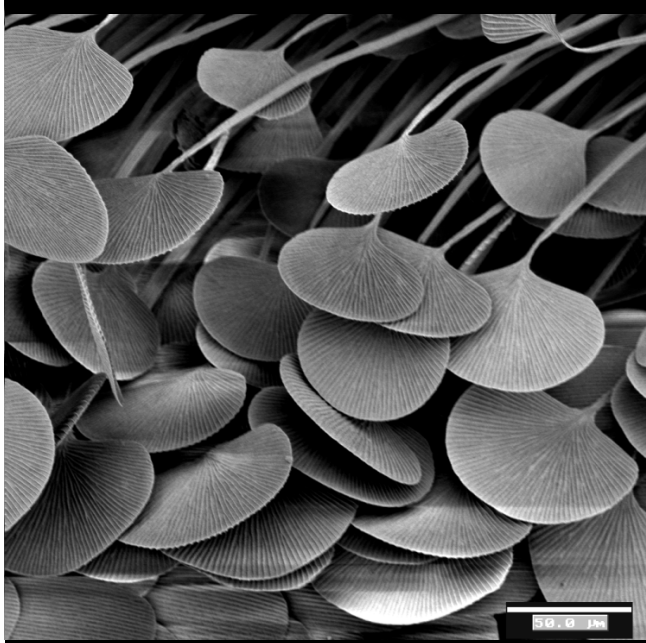


**3. Spatulate Scales**

## Pocket with Scales Having Both Glandular and Dissemination Functions

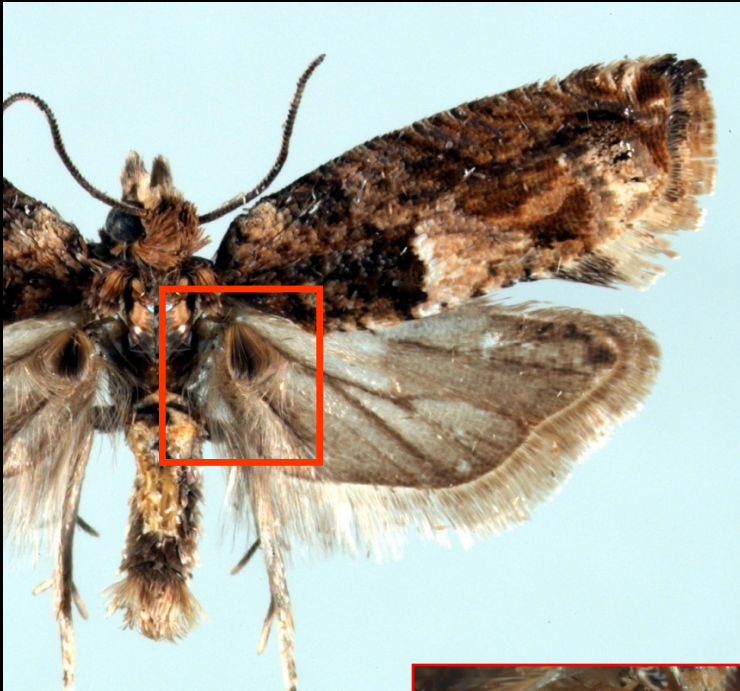


***Crocidosema lantana***



(Baixeras & Brown, in prep.)

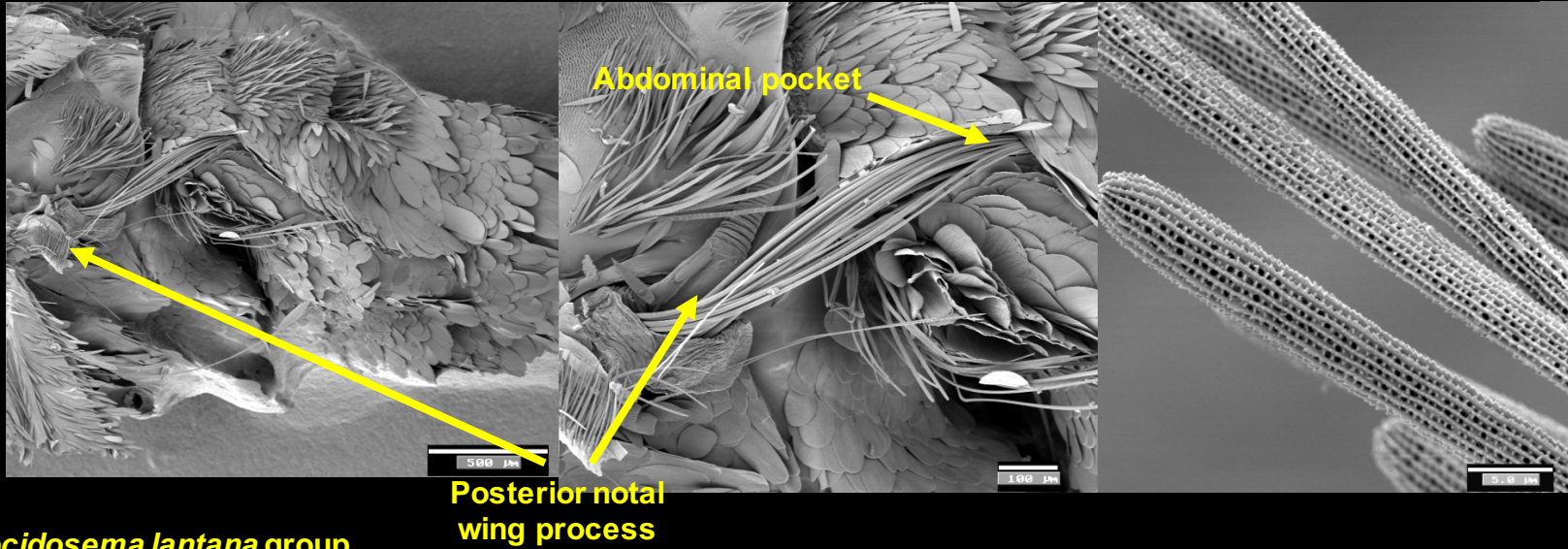
## Glandular and Dissemination Scales on Different Body Parts -I



*Crocidosema plebejana*

(Baixeras & Brown, in prep.)

## Glandular and Dissemination Scales on Different Body Parts -II



# Papilionoidea



*Carcharodus* (Hesperiidae) P. Bruce-Jones



*Atlides halesus* (Lycaenidae)

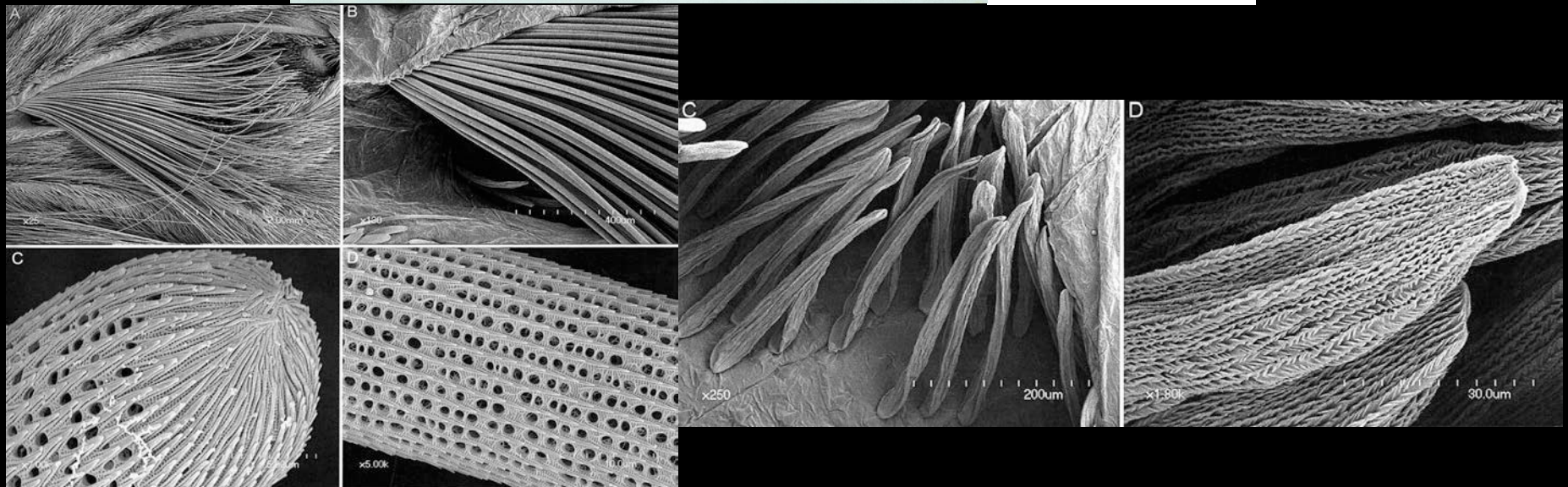
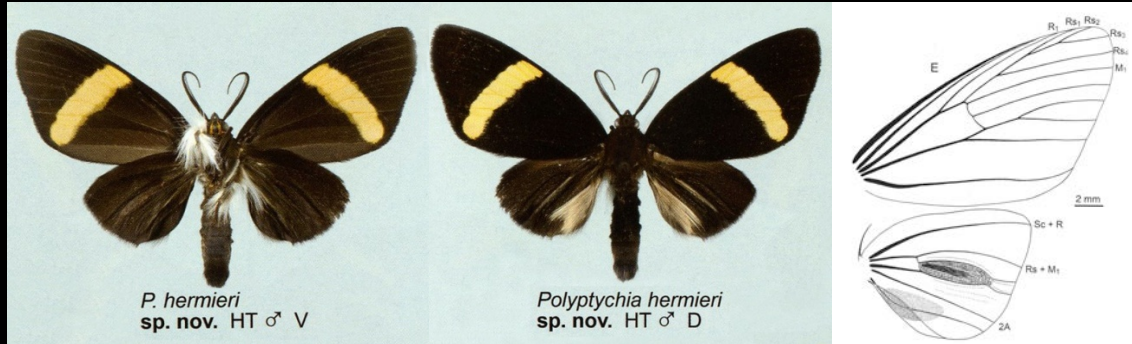


Nymphalidae Hans-Peter. Creative Commons



Pieridae

# Notodontidae (Dioptinae)



James Miller. 2009. Generic revision of the Dioptinae (Lepidoptera: Notodontidae).

# Pyralidae



Amanda Roe

Dioryctria

# Wicks for Dispersal of Deer Scents



## DEER WICKS (tm)

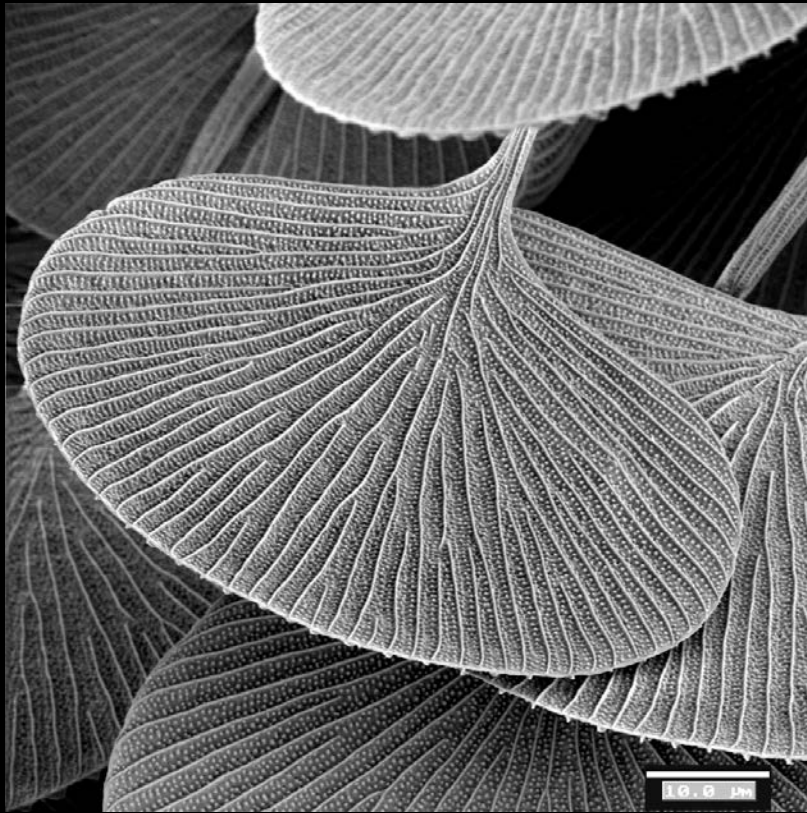
### The Best Scent Delivery System

We have carefully engineered our Deer Wick to be the best scent delivery system on the market

**Rain Guard:** Deer Wicks have an outer plastic shell that sheds rain, preserves scent, and keeps the scent pad active.

**Micro - holes:** Deer Wicks have hundreds of micro-holes and a unique air-flow through design to get scent airborne easily.

# Natural and Commercial Wicks



# Acknowledgements

We thank **William Munroe and Richard Kuklinski, MSU Electron Microscope Center**, for their assistance with microscopy.

**Photographs of living specimens of Gelechiidae and Tortricidae were obtained from the Moth Photographers Group website.**

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